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IEA Bioenergy

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Developing a web-based dashboard to merge SWOT analysis results from international biohub and supply chain case studies

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Abstract

A Bio-hub refers to an intermediate place where farmers/growers can deliver their by-products (such as straw, harvesting residues, etc.) to be processed into some commodities (e.g. dried wood, pellets, etc.) that can yield higher quality and values along the supply chain (Kulisic et al. 2019). Biohub concept can provide feedstock collection, intermediate pretreatment and storage – can be a promising tool to deal with the interface between supply chains and markets they serve. It is best to aim for a few commodity products, with well-defined quality criteria (IEA Bioenergy, 2019). IEA Task 43 has planned to support the development and delivery of the biohub development program with key biohub examples to ensure different countries and regions are represented and seek unique approaches to increasing quality, reliability, value and quantity. To combine the SWOT analysis results of the biomass case study results from different international regions a unique web-based dashboard was developed in this project. This dashboard can help the users understanding the strength, weaknesses and overall sustainability of the bio-hub projects. Such a web-based tool can provide a single access point that can facilitate comparison and bring attention more easily on a wide range of Task43 outputs. The dashboard is available to the users for free at https://arcg.is/qLqaK

Introduction

IEA Task 43 has planned to support the development and delivery of the biohub workshop program with key biohub examples to ensure different countries and regions are represented and seek unique approaches to increasing quality, reliability, value and quantity. The plan also included delivering a workshop including outcomes towards clearly defined SWOT for biohubs that is the foundation of field trials and assessments by the end of 2021. SWOT analysis has been completed by IEA Task 43 via workshops in Sopron (Hungary) and Ottawa (Canada). In addition to the biohub work, several supply chains cases studies were being captured in Task and intertask activities (e.g. WB2/SDG project that covers several international supply chain projects) that could be presented in the proposed platform. IEA Bioenergy does not offer an accessible platform with a variety of studies and project outcomes on biohubs and biomass supply chains. To combine these SWOT analyses and case study results from different international regions a unique web-based dashboard could be of help to the users (e.g. growers, processors, investors, planners etc.) for understanding the strength, weaknesses and overall sustainability of the bio-hub projects. GIS-based dashboards are web apps that can be configured to include maps, charts, gauges and other visual elements (Gružas, 2021). Such a web-based dashboard can provide a single access point that can facilitate comparison and bring attention more easily to a wide range of Task43 outputs. The targeted users of the proposed web-based dashboard include biomass supply chain operators, bioenergy producers and possibly wood products prodcuers plus other parties with a general interest in seeking knowledge on the biomass supply chain (Heeley et al. 2019). The users have been already consulted through various T43 activities and a specific consultation will be carried out in an early stage of this proposed project to capture the user requirements. Thus, this project aimed to develop a web-based dashboard to combine the SWOT results of international bio-hub and supply chain case study results.

Methods

Firstly, the SWOT analysis and detailed study results were collected from the bio-hub case studies and supply chain case studies. A basic template including the background information and SWOT analysis results of each case study was created to add the case studies to the web platform (Appendix 1). The template was sent to international researchers to receive the required information.

Relevant information and literatures related to SWOT analysis of the IEA biohub/supply chains activities were collected that were subsequently orgnaized in a spreadsheet. The geographic component of each information was extracted manually and converted to geographic locations (latitude and longitude) using existing spatial data sets. Using the geographic locations, the spreadsheet was converted to a GIS layer with ArcGIS Pro 2.3 software package. The GIS layer was converted to web map and thereafter shared on ArcGIS Online which is cloud-based software to create and share interactive web maps (ESRI, 2021b). ArcGIS online has been used for sharing maps, data and 3d products for diverse purposes (Srivastava *et al.*, 2021). The shared map was used for creating an online dashboard using ArcGIS Online which enables users to convey information and data by presenting location-based analytics in a single view (ESRI, 2021a).

Review of SWOT analysis results for selected case studies

One of the main challenges in biomass utilisation has been producing a bundle of bio-based products without disturbing the usual process of woody biomass and crop production. The idea is to continue work as usual but to find more effective and efficient ways in which the so-called waste can be retrieved and included in the value process. A bio-hub refers to an intermediate place where farmers/growers can deliver their by-products (such as straw, residues, etc.) to be processed into some commodities (e.g., dried wood, pellets, etc.) that can yield higher quality and values along the supply chain (Kulisic et al. 2019). The role of the bio-hub is that of a recycling plant, repository, but also research and development space to test and trial new waste innovations. Biohub concept can provide feedstock collection, intermediate pretreatment and storage – can be a promising tool to deal with the interface between supply chains and markets they serve. It is best to aim for a few commodity products, with well-defined quality criteria (IEA Bioenergy, 2019).

Kulisic et al. 2019 run a workshop where 55 participants from 17 countries attended to outline the strengths, weaknesses, opportunities, and threats (SWOT analysis) of having a bio-hub as an alternative to the existing biomass supply, which includes forestry, agriculture, and short rotation crops (SRC). The SWOT analysis provides a quick overview of the main internal and external aspects to consider, and decisions can be made faster. It helps bioenergy managers to take advantage of favourable circumstances and to deal with challenges faster which can provide a competitive advantage. Our SWOT analysis followed the methods of Humphrey (2005) and was performed in real-time, capturing, scoring, and ranking inputs from 30 workshop attendees. The results indicated that the intensity of opportunities was higher ranked than those of weaknesses and threats by the participants. The top three opportunities included improving biomass supply, improve biomass valorisation, and improving the economics of the supply. The main weaknesses identified included the challenge of organisation and running the supply chain, challenges associated with start-up costs, and potential undesirable socio-economics issues associated with bio-hubs. The highest rank weakness was that this would be a "too large investment" and the highest scored strength was the security of supply (Table 1).

When reflecting on the top opportunities it was mentioned that taking biomass supply to the next level is important for a variety of reasons, one being that it will trigger many socio-economic benefits, and can assist in establishing a positive political framework. The threats were classified into two groups; size-related threats (such as having too much market influence, higher risks to disastrous events due to the higher volumes and lower public support for large projects) and sustainability-related threats.

The sustainability-related threats were classified into three categories;

- environmental (potential negative impact on biodiversity and other ecosystem services due to overuse of biomass),

- social (poor connection to the local community, and lack of cooperative initiatives to create value optimisation) and

- economic (long term investment versus versatile market, the outflow of the biomass from the country, lack of market and technology readiness to switch to bio-based alternatives).

Another workshop was held in Canada using three groups in three regions (Western Canada, Ontario, and Quebec, Eastern Canada) to evaluate the preferences regarding the SWOT of the bio-hubs. Table 2 contains the listed SWOT's (sorted based on preference from the top (high) to down (low) (Nasso and Sweazey, 2020).

Table 1: Full list of SWOT results identified in the Sopron workshop sorted from high to low preference (Kulisic et al. 2019)

Strength	Security of supply, Handle biomass from multiple sources, Flexible supply from a diverse set of feedstocks, Better quality control, Using biomass of appropriate quality for the appropriate usage, Flexibility, Scale economics, Netter market access for smallholders, Value optimisation, Market development security of supply diversification, Facilitate access for buyers, Security of supply, Standardisation of products, Market resilience, Value-added focus rather than cost centred approach, Integration of various biomass sources, Better organized size economy, Better economy, Clear and more reliable statistical numbers about supplies, Better bargaining power, More economy of scale, Regional development, Room for several buyers and sellers, More cost-effective, Economic of scale, Economic efficiency, Cost efficiency.
Weakness	Large investment need infrastructure financing, How to standardise products, Organisation, Large investment cost, Ownership, who is responsible, Parallel system to existing supply chains controlled by large companies, Expensive, More complicate to design, Risky investment, Need more participants complex to run, The necessity of related biomass sources, Biomass origin, The complexity of the value chain increases, A player with a monopoly maker situation, Competition with local smaller users, Large input-data needs optimal design and operation, The bad image of imported/on long distances transported biomass, Quality control, Difficult return of nutrients to the sites.
Opportunities	Improve certification schemes, Development of the new market for farmers and forest owners, Value optimisation, Storage management is easier, Value-adding easier, Higher added value, Address industrial clients, Way to secure & just in time supplement of biomass, New business opportunity for farmers and foresters, Meet the increasing demand for bio-sourced inputs, Improve traceability, Standardised products, Creating a form of marketplace, Efficiency, Large policy support, Raising competitiveness, More companies will be convinced to use wood resources as its supply gets more reliable, Common applications, Lower cost of biomass, Lobbying, More jobs in a rural area, Farmers friendly, Economies of scale, Industrial applications require large amounts of consistent quality inputs.
Threats	Large impact on all users in case of disaster or accidents, Too much market influence, Need to manage relationships with multiple raw biomass providers, Long term investment vs versatile market, Sustainability can become an issue, Dominant market position, The outflow of the biomass from the country, No demand, Lower public support for large projects, Higher volume and higher risks, Lobbying power, Wide standards leading to unreliable product, Potential negative impact on biodiversity and other ecosystem services due to overuse of biomass, Minimum size, Insufficient knowledge in the primary sector for the switch, Lack of cooperative initiatives to create value optimisation.

Table 2: Full list of SWOT workshop results in Canada sorted from high to low preference (Nasso and Sweazey, 2020)

Strength	Availability of suitable biomass, Good quality and quantity of feedstock, providing economies of scale, Good environmental credentials, Established infrastructure and primary assets, Existing supply chains.
Weakness	Complex intergovernmental structures and priorities (Federal/provincial), Limited access to capital in an uncertain environment, Lack of market for bio-based products, Transport distances, Indigenous relations, Lack of accurate spatial inventory data, Lack of higher-value markets for feedstocks to offset the extra costs of biohubs.
Opportunities	Underutilised feedstock, The entry point for non-traditional players, Emerging carbon markets could create demand/value for products, Economies of scale allowing access to new markets and investments, Optimization of existing forestry and agriculture processes, Potential greater collaboration, Ability to leverage HQP's, infrastructure, and markets from other sectors.
Threats	Uncertainty (impacts of climate change, policy support, economics/markets), Past failures of bioenergy projects leading to no (or low) investor confidence, Inability to launch a national bioeconomy strategy, Traditional forest sector industry declines and/or collapses, Increasing frequency and impacts of natural disturbances, Lack of collaboration from established industries, Regularity environment favours export instead of domestic use.

Result: Web-based dashboard

The dashboard is available at https://arcg.is/qLqaK which can be accessed for free by any user. Some examples of biomass case studies (7 case studies) were uploaded to the map. These included case studies in North America (2 case studies), South America (1 case study), Europe (1 case study) and Australia (3 case studies). Figure 1 presents the overall picture of the web-based dashboard. At the left side of the window (Figure 1) from top to down the project names, the name of project officers who provided data and the location (country) of each case study are illustrated. In the middle of the window a global map is shown where the case studies are marked in various regions. The right side of the window includes three boxes from top to down distribution of regions, last update graph and total number of observations (case studies) uploaded into the map (Figure 1).

Figure 1: Main page of the web-dashboard

To view the details of each case study the users can zoom in near the location of the case study. When clicking on the location point a box will open which contains information on location, biomass characteristics and SWOT results of the case study (Figure 2).

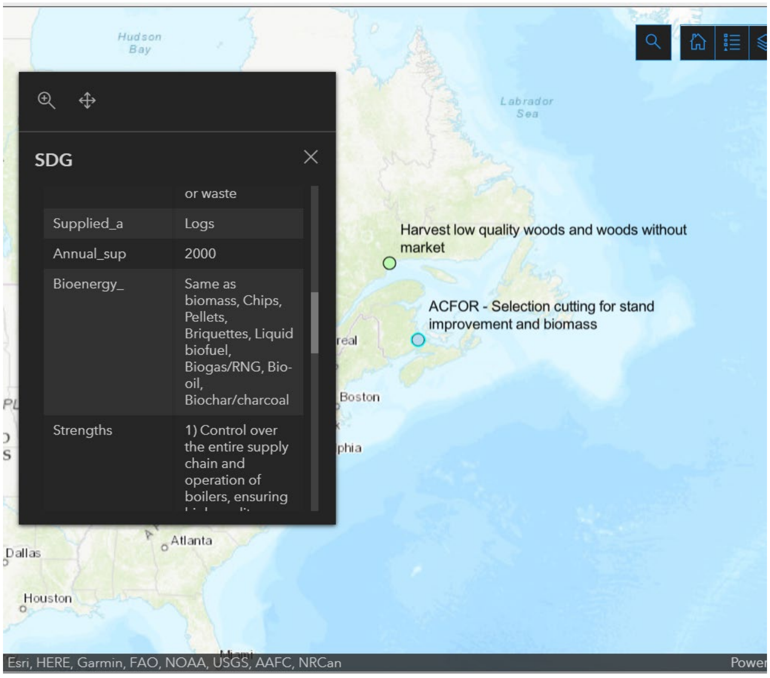

Figure 2: Detailed information of a case study displayed by the web-dashboard

Conclusions and future implications

Biohubs and biomass supply chain case studies/projects have been developed in different regions of the world where some of these projects were supported by IEA bioenergy. Each case study/project creates a new management experience for the bioenergy industry that results in a specific list of strengths, weaknesses, opportunities, and threats. The SWOT results helps managers to make critical decisions and the process of compiling the SWOT helps these managers to understand their own operations and the environment in which they operate more effectively. The web-based dashboard developed in this project would assist the bioenergy industry users, investors, government agencies and planners to access the summarised information on technical background and SWOT results of the various case studies. The users can upload their data on new projects to populate the web-based dashboard. Once the tool is equipped with a large data set then future R/D works could look at developing the tool functions e.g., for making comparisons among the similar biohub/biomass projects in terms of sustainability performance (e.g., using multiple criteria decisions making) or any other analytical capability required by the bioenergy/biochar industry. The biomass supply chains in different regions can also be compared to gain new knowledge and information to help improving the efficiency and sustaianablity.

The strengths for all the participating stakeholders in the cases/projects were identified as the availability of biomass. This previously unimportant and undervalued part of the value chain should be managed proactively and with the focus on having a diverse range of suppliers. The availability of multiple sources also provides opportunities to having more sustainable impact on the environment with less waste and contributing to the circular economy. This will in turn create economic and social benefits for local communities. The strengths can lead to an uptake of opportunity to develop this as a market and to provide ways in which the value of this can be measured and support future product development and innovation in the organisations, region and industry level. The cases also indicates that established infrastructures and networks can be utilised for these further developments, and that an approach should include leveraging existing assets, collaborating and continuously enhance relationships in the industry. The web-based dashboard become a useful instrument where the internal capacity can be identified and utilised for future strategies.

It is however important to note that a shared concern for all cases were the lack of financial infrastructure and resources to expand and diversify existing operations. Not having a clear idea of the return on investment it is also difficult to forecast and plan these activities and the rate of adoption. The lack of the clear impact on the organisation leads to increased risk and hesitancy to proceed. The web-based dashboard can minimise the uncertainty around how to bridge these gaps. The tool helps in articulating the gaps and to provide a better understanding of the less developed areas and where to focus future resources to improve and enhance those areas.

The opportunities for future outcomes that were mentioned in these projects include opportunities to increase internal quality and increased value which leads to environmental and economic impact. By creating a market for these products, it will provide wider community and social value for spin-offs, and employment opportunities. This can help organisations to overcome their limitations (weaknesses) and obstacles (threats) to increase the overall company value and offer diversification of production. These projects identified real-time threats that the industry and government should consider when developing these opportunities. The web-based dashboard also supports this by helping in the analysis of the vulnerabilities, uncertainties and uncontrollable issues faced by the stakeholders. Continuous market development and clear articulation of value will increase the likelihood of sustainable practices. The increase in demand for these products and education around the environment, social and economic value will be decreasing the threat of no demand, insufficient knowledge and lack of collaboration in the industries and broader community.

From these projects the following strategies can be recommended for industry and government to consider for sustainable and responsible management:

Biomass availability: By utilising this tool the academic and industry stakeholders can achieve a transparent collaboration platform. Small and Medium sized businesses (SMEs) can after further development of this tool also then have more inclusivity in the industry. Continuous development of the tool can produce a robust inventory of activity and this can lead to more inclusive and diverse industry participation. SMEs, social ventures, and non-profit stakeholders in the community will also be able to access the information will support the social and economic improvement of local communities and widen the scope and impact of the industry. Optimising the strength-opportunity fit by ensuring an increased availability of biomass. A continuous focus on maintaining the required quality and suitable biomass that can be utilised industry wide as a competitive advantage. Sufficient volume at the required standard will lead to economic value where economies of scale can be reached.

Increased agility: By having the access to a flexible, agile, and well-established supply chain the industry can overcome increase their capacity and ability to manage projects and this can lead to greater market credibility and reputation. This will help in overcoming the weaknesses by focusing on the strengths of the participating biomass value chains.

Reduced uncertainty: By having this structured tool and platform for future development the difficulty of managing the complex governmental and regulatory structures and meet their priorities, making the organisations even more vulnerable in uncertain markets and hampering their progress.

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Appendix

Appendix 1: Template to collect the data including an example of biomass case study

Project type	SDG
Officer	Mohammad-Reza Ghaffariyan
Number	1
Case study	Supply chain
Authors	John McGrath, Kevin Goss, John Bartle, Richard Harper
Year	2016
Reference	Integrated tree crop systems in south-western Western Australia at https://s3-ap-southeast-2.amazonaws.com/piano.revolutionise.com.au/cups/bioenergy/files/tdejzvr2rugphuf2.pdf
City/town	N/A
Region/State	Western Australia
Country	Australia
Biomass type	Woody
Biomass production	Short rotation trees
Supplied as	Bulk woody mass or chips
Annual supply (GMt)	130000
Bioenergy product	Pellet, Biofuel, Bio-oil
Strengths	Improved aquatic and wetland systems (including reducing groundwater recharge, diverting saline inflows and keeping groundwater suppressed)
Weaknesses	Lower yield of biomass per ha due to the nature of integrating trees with agricultural land (resulting in higher cost of biomass recovery), Uncertainty for farms and environmental programs
Opportunities	Potential use of woody biomass in WA wheatbelt and using cropping residues
Threats	Competition with other crops, Competition with solar and wind